

Creating a Work Breakdown Structure

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Software Process Improvement (SPI) Project

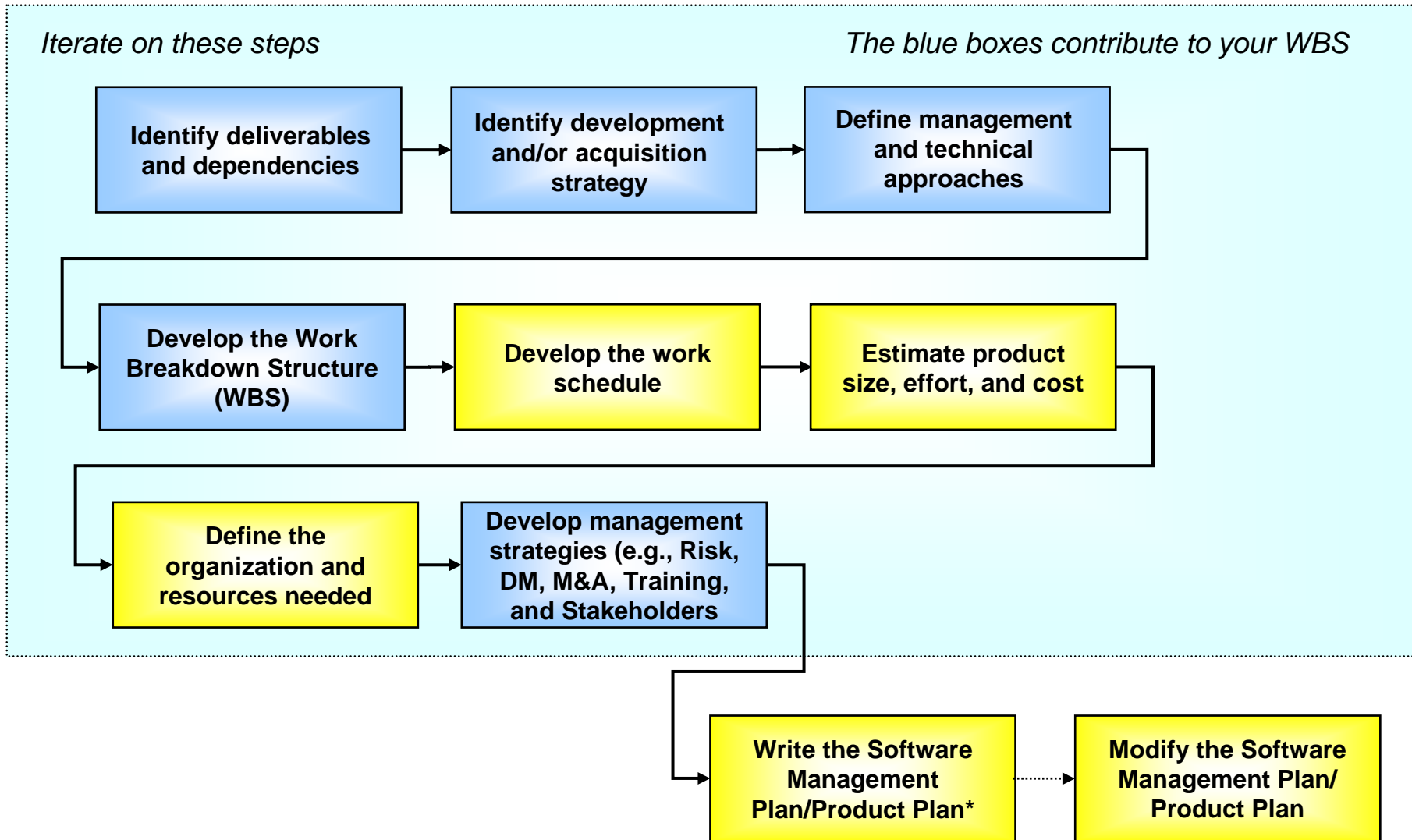
Purpose and Objectives

- **Purpose: Discuss the importance of your WBS and how to create a good one**
- **Objective - After this session you should understand:**
 - **Why a WBS is important**
 - **The steps in creating a Work Breakdown Structure (WBS)**
 - **How to use the SPI WBS Checklist tool**
 - **Some of the potential WBS pitfalls**

Your WBS Is Important to Planning

- **It provides a framework for the rest of your project planning**
 - **It helps ensure that all project work is included in the plan**
 - **It promotes accurate estimation and objective measurement**
- **You can apply past experience by comparing new and old WBSs**

Project Planning Tasks Related to the WBS



Your WBS Is Important to Monitoring

- It provides a comprehensive, consistent tool for collecting and reporting status
 - It is the basis for measuring schedule progress against your plan
 - It is the basis for measuring cost progress against your plan
 - It is the basis for reporting status to management

*Remember the “5-P Rule”:
Proper Planning Prevents Poor Performance*

Understand the Definitions

■ What is a product?

- *Something concrete*, such as a document, hardware, software module, or a process artifact
- Or *a service* provided to the project or customer

■ What is a WBS?

- A *product-oriented, hierarchical structure* that defines all work required for the hardware, software, data services, and process activities to be provided or performed by the project

■ What is a WBS Dictionary?

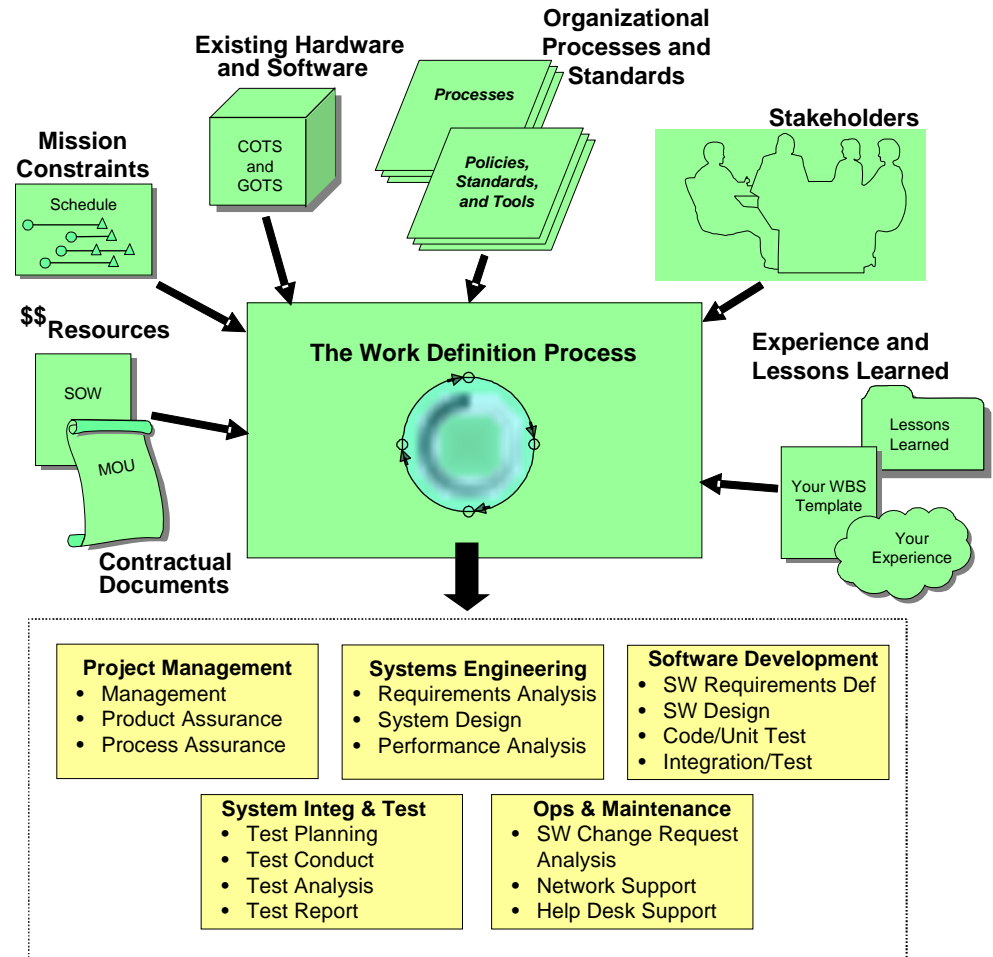
- A *definition of the scope* of each WBS element

Steps to Creating a WBS

- 1. Identify all products and services you are required to provide**
- 2. Define the elements of work needed for each product or service**
- 3. Add the work needed to meet management requirements of NPR 7150.2**
- 4. Finalize the WBS by iterating until it is complete**

1. Identify What Products Are Required

- **Scope your project**
 - Identify all products
 - Group like products
 - Break into sub-products
- **Use as many input references as you can**
 - Your contract or SOW
 - Mission schedules
 - Mission cost constraints
 - The PAL assets
 - Customer input
 - Your experience



2. Define the Work for Your Product

- **Identify your make/buy strategy**
 - Make it from scratch
 - Modify an existing product
 - Buy it
- **Select a life cycle model**
- **Identify technical work elements needed for each product and sub-product**

3. Add Management Activities

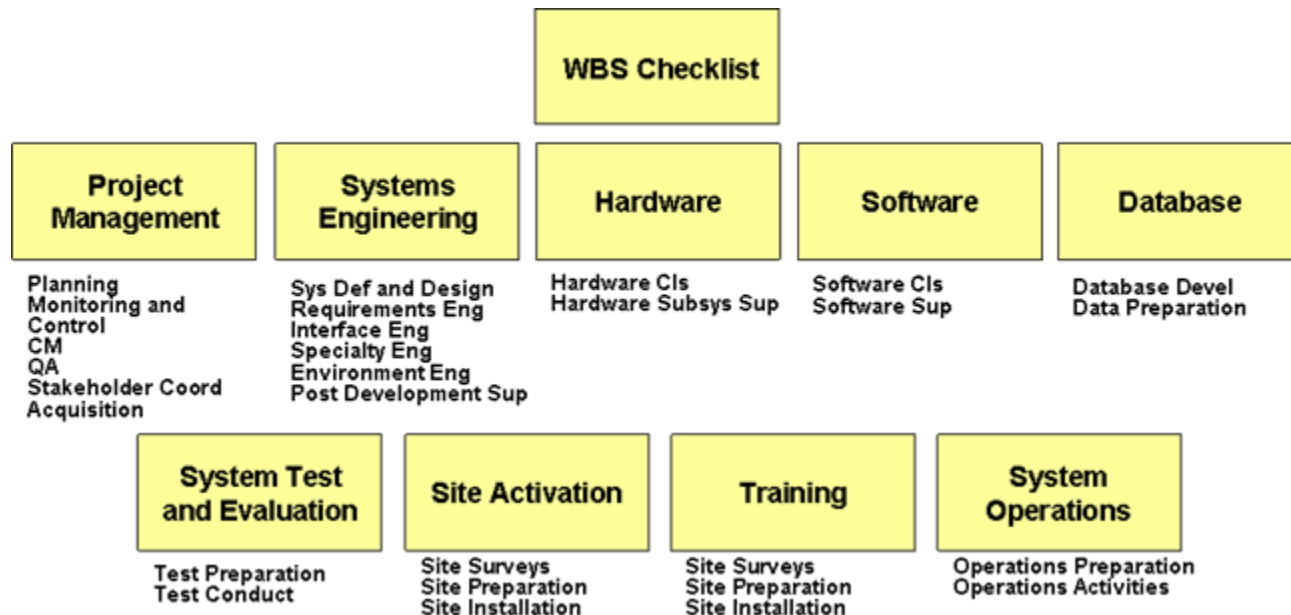
- **Identify additional work elements needed to meet NPR 7150.2 requirements**
 - **Planning and monitoring activities**
 - **Reporting activities**
 - **Acquisition activities**
 - **Technical monitoring activities (peer reviews, formal reviews, etc.)**
 - **Risk management activities**
 - **Measurement activities**
 - **Stakeholder coordination activities**
 - **CM and PPQA activities**

4. Finalize Your WBS

- **Iterate as you refine schedule and cost estimates**
 - Factor in identified risks and mitigation strategies
 - Group the work elements based on organizational WBS standards or best practices
 - Keep planned work aligned with budgetary allocations
- **WBS activities must result in all required products, sub-products, and services**
- **Make your WBS product- and service-oriented, not organization-oriented**
- **Document what each WBS element includes in a WBS dictionary**

Use a WBS Checklist as a Starting Point

- **Start with an organizational standard or the WBS Checklist Tool**
 - Keep all management activities that apply
 - Don't forget acquisition, risk, data management, and measurement activities
 - Keep all technical activities that apply
 - Remember things like rework and training
 - Keep all process activities that apply
 - Include activities associated with stakeholder coordination and with measuring and improving process
 - Identify any additional activities that apply and add them to your WBS



The WBS Checklist Tool

- Some organizations have their own WBS standard or checklist
- Otherwise, a **WBS Checklist Tool** is available at <http://software.gsfc.nasa.gov/tools.cfm>
 - *WBS Elements that support CMMI process areas* are noted as required
 - It provides a comprehensive list of top-level WBS elements to be considered for your WBS
- Use the appropriate checklist or standard as your starting point
 - Eliminate elements that don't apply and add or expand elements as necessary

What the SPI Checklist Looks Like

1 PROJECT MANAGEMENT			
1.1	Project Planning		
1.1.1	Plan the Technical Approach	Plan the technical (and engineering) approach	Required
1.1.2	Plan the Management Approach	Plan the management approach, including: Estimate (and re-estimate) project costs Plan (and replan) the project staff Plan the monitoring and control approach and activities Plan the measurement and analysis activities Plan the Data Management approach Identify initial risks and develop risk strategy Create (and maintain) the schedule of work (based on the WBS) Identify the number of builds planned and the basic build contents	
1.1.3	Develop and Maintain the SMP/PP	Write, review, and maintain the management plan based on the approved template.	
1.2	Project Monitoring and Control		
1.2.1	Prepare Measurement Environment	Install the metric tools and repositories as needed	Required
1.2.1	Perform Monitoring Activities	Monitor and control the effort through the following activities: Collect and store metric data monthly Compare actual data to plan monthly Analyze metric data monthly Get status from Team leads or members weekly Identify, track, and resolve issues and actions Review the risks and update status at least monthly Verify that data management activities are ongoing Track receivables against the schedule	
1.2.3	Prepare and Report	Report status to management and stakeholders; track and resolve issues and actions identified during reporting	
1.3	Configuration Management		
1.3.1	Plan CM Approach	Plan the CM approach (you may tailor an organizational approach); write and maintain the CM Plan; select, obtain, and install CM tools	Required
1.3.2	Conduct CCBs	Assess and manage configured items (requirements, software, hardware, and documents); disposition and track CRs	
1.3.3	Baseline CI Configuration	Identify, configure, and baseline the configuration items	
1.3.4	Build Dev Baseline Configuration Audits	Conduct and support CI audits	
1.3.5	Resolve CM Process Audit Findings	Address audit findings	

3 HARDWARE			
3.1 Hardware Configuration Item 1 (repeat for each CI)			
3.1.1	Define HW Requirements	Develop and document the hardware requirements	Required for hardware
3.1.2	Define HW Preliminary Design	Develop a high-level hardware design and conduct a review	
3.1.3	Define HW Detailed Design	Develop the detailed hardware design and conduct a review	
3.1.4	Perform HW Acquisition and Verification	Acquire the hardware components and verify that they meet specifications	
3.1.5	Perform HW Integration and Checkout	Integrate the hardware and verify performance of the integrated hardware system	
3.2 Hardware Configuration Item 2			
3.3 Hardware Configuration Item 3			
3.4 Hardware Subsystem Support			
3.4.1	Develop HW Diagnostics	Develop any hardware diagnostics that are required	
3.4.2	Support Special HW/SW Tests	Support the customer in any special hardware/software testing	
3.4.3	Support HW I&T	Support the customer in integration and test activities	
3.4.4	Support Payload I&T	Provide support for integration and test of any payload systems	
4 SOFTWARE			
4.1 Software Configuration Item 1 (repeat for each CI)			
4.1.1	Develop SW Requirements (SEE NOTE)	Develop software requirements; analyze system requirements to identify, expand, and clarify software requirements; document the software requirements in accordance with the project standard; and conduct a Software Requirements Review to ensure stakeholder agreement	Required for software or firmware implementation
4.1.2	Develop SW Design (SEE NOTE)	Develop the high-level software design; conduct a Preliminary Design Review to ensure stakeholder agreement; develop the detailed design; document the design in accordance with the project standard; conduct a Critical Design Review to ensure stakeholder agreement	
4.1.3	Implement Build 1	Develop the software for the build; unit-test the software; integrate the units and perform developer testing on the build; perform independent testing on the Build, including development of test requirements, test plans, test scenarios, and test procedures; document test results.	
4.1.4	Implement Build 2	Develop Build 2 (same activities as Build 1)	
4.1.5	Implement Build 3	Develop Build 3 (same activities as Build 1)	
4.2 Software Configuration Item 2			
4.3 Software Configuration Item 3			
NOTE: Requirements and design can be conducted for all CSCIs jointly, with only the implementation effort broken into separate WBS elements for each CSCI.			

WBS Checklist Tool Top Levels: Development

1 PROJECT MANAGEMENT

- 1.1 Project Planning
- 1.2 Project Monitoring and Control
- 1.3 Configuration Management
- 1.4 Quality Assurance Support
- 1.5 Stakeholder Coordination
- 1.6 Acquisition Management

2 SYSTEMS ENGINEERING

- 2.1 System Definition and Design
- 2.2 Requirements Engineering
- 2.3 Interface engineering
- 2.4 Specialty Engineering
- 2.5 Development and Test Environment Engineering
- 2.6 Post Development Support

3 HARDWARE

- 3.1 Hardware Configuration Item 1 (repeat for each CI)
- 3.n Hardware Subsystem Support

4 SOFTWARE

- 4.1 Software Configuration Item 1 (repeat for each CI)

5 DATABASE

- 5.1 Database Development
- 5.2 Data Preparation

6 SYSTEM TEST AND EVALUATION

- 6.1 Test Preparation
- 6.2 Test Conduct

7 SITE ACTIVATION

- 7.1 Perform Site Surveys
- 7.2 Perform Site Preparation
- 7.3 Perform Site Installation

8 TRAINING

- 8.1 Team Training
- 8.2 Customer/User Training

9 SYSTEM OPERATIONS

- 9.1 Operations Preparation
- 9.2 Operations Activities

WBS Checklist Tool Top Levels: Acquisition

1 ACQUISITION PLANNING

- 1.1 Project Planning
 - 1.1.1 Management Approach
 - 1.1.2 Acquisition Approach
 - 1.1.3 Write/Update Software Acquisition Management Plan (SAMP)
- 1.2 Project Monitoring and Control
- 1.3 Project Configuration Management
- 1.4 Project Process and Product Quality Assurance
- 1.5 Report Status

2 CONTRACT SOLICITATION, SELECTION and AWARD

- 2.1 Prepare Acquisition Package/Distribute RFP
- 2.2 Evaluate Proposals and Select Contractor
- 2.3 Negotiate Contract and Get Signatures

3 CONTRACT MONITORING and QUALITY ASSURANCE

- 3.1 Interpret Technical Requirements
- 3.2. Evaluate Contractor Progress With Respect to Cost
- 3.3 Monitor Contractor Skill Mix
- 3.4 Oversee GFE
- 3.5 Monitor Contractor Processes
- 3.6 Manage Documentation
- 3.7 Status Reporting to Management
- 3.8 Monitor Risks

4 CONTRACT ADMINISTRATION

- 4.1 Review Contractor invoices/Manage Budget
- 4.2 Reporting of Contract Issues to CO
- 4.3 Initiate Needed Contract Changes
- 4.4 Provide Evaluation of Contractor Performance

5 PRODUCT ACCEPTANCE & CONTROL

- 5.1 Review Deliverables for Acceptance
- 5.2 Perform Configuration Management
- 5.3 Transition Products to Ops/Maintenance

6 CONTRACT CLOSE-OUT

- 6.1 Monitor Completion of Contract Requirements
- 6.2 Validate GFE Inventory
- 6.3 Submit Final Reports
- 6.4 Complete Final Performance Assessment Report

Using the Checklist

1.6	Acquisition Management		
1.6.1	Determine Acquisition Needs	Identify all hardware and software that will be procured by the project to the extent possible	Required for acquisitions
1.6.2	Plan for Acquisitions	Establish the plan for any acquisitions identified	
1.6.3	Select Suppliers	Identify the desired supplier for each item to be procured. Supplier may be sole source (justification needed) or selected based on identified criteria.	
1.6.4	Issue Procurements	Create or support the creation of procurement documents based on the governing processes from the Project or the Procurement Office, as applicable	
1.6.5	Monitor Contractor Process and Products	Monitor contractor process implementation (through reviews, meetings, etc.; monitor contractor status; monitor contractor product quality)	
1.6.6	Accept Products	Receive product; verify it is the correct item in the proper quantity, and in good condition; install and test the item in the appropriate environment.	
1.6.7	Ongoing Procurement Needs Monitoring	Assess and process any additional procurement needs, quarterly at a minimum.	
2	SYSTEMS ENGINEERING		
2.1	System Definition and Design		
2.1.1	Develop System Concept Definition	Develop (or support) the overall system concept	
2.1.2	Perform Trade Studies and Engineering Analyses	Perform trade studies, feasibility studies, etc.	
2.1.3	Perform Make/Buy and COTS/GOTS decisions	Based on system concept and design, perform make/buy studies; for components that are not "make", conduct COTS/GOTS analysis and make recommendations	
2.1.4	Develop Architecture Definition	Develop (or support) the overall system architecture	
2.1.5	Develop System Design	Develop (or support) the overall system design	
2.2	Requirements Engineering		
2.2.1	Define and Analyze Requirements	Analyze, define, and document the system requirements; allocate them to system components; create and maintain a bi-directional requirements traceability matrix.	Required
2.2.2	Perform Requirements Management	Implement requirement change control	
2.3	Interface Engineering		

■ Decide which WBS elements are applicable to your project

– If a WBS element is marked as required, you **MUST** *show the work somewhere* in your WBS

– Keep all WBS elements that apply to your project

– Drop all WBS elements that don't apply to your project

■ Combine or expand your WBS elements as appropriate for your project

– Adjust the WBS dictionary to show combined elements

– Add additional levels to show expansions

Your WBS Can Differ from the Checklist

- **WBS elements can be ordered differently**
 - Management is normally first
 - Ordering of hardware, software, etc., can vary (elements are normally ordered by life cycle)
- **WBS elements can be given different names**
 - For example, “**Development and Test Environment Engineering**” could be called “**Software Environment**”

There Are Multiple Ways to Organize a WBS

- For example, either of the following is a valid WBS

Requirements and Design
shown separately for each CSCI

4.1	Software Configuration Item 1
4.1.1	Develop SW Requirements
4.1.2	Develop SW Design
4.1.3	Implement Build 1
4.1.4	Implement Build 2
4.1.5	Implement Build 3
4.2	Software Configuration Item 2
4.2.1	Develop SW Requirements
4.2.2	Develop SW Design
4.2.3	Implement Build 1
4.2.4	Implement Build 2
4.2.5	Implement Build 3
4.3	Software Configuration Item 2
4.3.1	Develop SW Requirements
4.3.2	Develop SW Design
4.3.3	Implement Build 1
4.3.4	Implement Build 2
4.3.5	Implement Build 3

Requirements and Design
shown once for all CSCIs

4.1	Develop SW Requirements
4.2	Develop SW Design
4.3	Develop Software
4.3.1	Software Configuration Item 1
4.3.1.1	Implement Build 1
4.3.1.2	Implement Build 2
4.3.1.3	Implement Build 3
4.3.2	Software Configuration Item 2
4.3.2.1	Implement Build 1
4.3.2.2	Implement Build 2
4.3.2.3	Implement Build 3
4.3.3	Software Configuration Item 3
4.3.3.1	Implement Build 1
4.3.3.2	Implement Build 2
4.3.3.3	Implement Build 3

Keeping Your Own Checklist

- **Maintain your own checklist of lower-level WBS elements you might need**
 - **If you encounter work not planned on a project, add it to your list so you don't forget next time**
 - **A few of the things often forgotten ...**
 - **Interface and coordination activities**
 - **Development of analysis software data (e.g., modeling and performance analysis)**
 - **Development of test data**
 - **Correction of discrepancy reports made on previous builds (build maintenance)**
 - **Team training**

Using the WBS

- Once **ALL** work the project will have to do is reflected in the WBS
 - Use the WBS to support cost and effort estimation
 - Estimate at each lowest-level WBS element and roll the estimate up
 - Use the WBS to schedule the work
 - Select the level of detail desired in the schedule and use WBS elements to that level as the schedule basis
 - Use the WBS to monitor and report on the work
 - Monitor and report status on the WBS elements in the schedule

Products of the WBS creation process that should be kept in the project data stores:

- **Artifacts from the WBS creation process, such as meeting minutes with rationale for decisions made**
 - Make/buy decisions
 - Life cycle decisions
 - Approach decisions
- **Interim versions of the WBS from iterations of the WBS creation process**
- **All elements included in the final project WBS**

Watch Out for the WBS Pitfalls

- **Not including all necessary work, such as**
 - Training in unique project technology or processes
 - Development rework during testing
 - Maintenance of early builds as next build is developed
 - Work associated with collection and analysis of measurement data
 - Work associated with data management
 - Work associated with stakeholder coordination
- **Not defining WBS elements to a low-enough level**
- **Not grouping WBS elements properly**

Summary

- Use a your checklist as a starting point
- Identify all products and services to be provided
- Make sure your WBS defines ALL work needed to provide the products and services
 - Don't forget the work associated with tracking and mitigation of project risks
 - Don't forget measurement and stakeholder coordination activities
 - Use past history and lessons learned to identify work missed in the past
- Document your plan and iterate until all areas are covered

Questions?